

CLAIMS

1. A process for recovering a precious metal from a sulfidic material comprising the steps of:
 - preparing an acidic aqueous halide solution having an oxidation potential sufficient to
 - 5 oxidise the sulfidic material and render the precious metal *soluble in the solution*;
 - adding the material to the acidic aqueous halide solution so that the sulfidic material is *oxidised and the precious metal is solubilised*; and
 - separating the precious metal from the oxidised sulfidic material.
- 10 2. A process for recovering a precious metal from a sulfidic material contaminated with arsenic comprising the steps of:
 - preparing an acidic aqueous halide solution having an oxidation potential sufficient to
 - oxidise the sulfidic material and render the precious metal soluble in the solution, and
 - having a pH at which the arsenic is precipitated;
 - 15 •adding the material to the acidic aqueous halide solution so that the sulfidic material is *oxidised, the precious metal is solubilised and the arsenic is precipitated*; and
 - separating the precious metal from the oxidised sulfidic material and precipitated arsenic.
- 20 3. A process as claimed in claim 1 or 2 wherein the solution bearing the precious metal is separated from the oxidised sulfidic material and precipitated arsenic (when present) in a solid-liquid separation stage, and the precious metal is then recovered from the solution in a metal recovery stage.
- 25 4. A process as claimed in claim 3 wherein in the metal recovery stage the precious metal is adsorbed onto activated carbon in one or more carbon-containing columns.
5. A process as claimed in claim 4 wherein after precious metal adsorption onto activated carbon the carbon is eluted with a cyanide solution and the eluate is passed to
- 30 an electrolysis stage for the recovery of the precious metal.
6. A process as claimed in any one of claims 3 to 5 wherein the metal recovery stage is provided in-line, after the solid-liquid separation stage, and prior to solution recycle to sulfidic material oxidation.
- 35 7. A process as claimed in any one of the preceding claims wherein the precious metal to be recovered is gold, silver, platinum or another platinum group metal.

8. A process as claimed in any one of the preceding claims wherein the aqueous halide solution is a soluble metal halide solution having a halide concentration of approximately 8 moles per litre.
- 5 9. A process as claimed in claim 8 wherein the halide is chloride or a mixture of halides comprising chloride and bromide.
- 10 10. A process as claimed in claim 8 or 9 wherein the metal in the dissolved metal halide solution is copper and/or iron and functions as a multi-valent species.
11. A process as claimed in any one of the preceding claims wherein the sulfidic material oxidation step comprises one or more leaching stages such that:
- 15 (i) for an un-contaminated single-refractory pyritic material the sulfidic material oxidation step comprises a single leaching stage in which the pyritic material is oxidised and the precious metal simultaneously solubilised; or
- (ii) for a contaminated single or double refractory pyritic material, the sulfidic material oxidation step comprises a two stage leaching process wherein the solution from the first leaching stage is fed to the second leaching stage.
- 20 12. A process as claimed in claim 11 wherein for (ii) the pyritic material is an arsenopyrite, and in a first of the leaching stages the oxidation potential is controlled to leach arsenic into solution and the solution pH is controlled such that, once leached, the arsenic precipitates as ferric arsenate, and in a second of the leaching stages the pyrite component is leached and the solution pH is controlled to maintain arsenic as a ferric arsenate precipitate so that the arsenic passes out of the process with the oxidised sulfidic material.
- 25 13. A process as claimed in claim 12 wherein in the first leaching stage the material is contacted with solution at an Eh of around 0.7-0.8 volts sufficient to leach the contaminant and solubilise the precious metal, at a solution pH is less than 1 but greater than about 0.5 so as to precipitate the arsenic immediately after it is leached, and at a solution temperature of about 80-105°C.
- 30 14. A process as claimed in claim 12 or 13 wherein in the second leaching stage the material is contacted with a solution having an Eh of around 0.8 – 0.9 volts sufficient to leach pyrite, the solution pH is less than 1 but greater than about 0.2 so as to precipitate
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the arsenic immediately after it is leached, and at a solution temperature about 90°C to 105°C.

15. A process as claimed in any one of the preceding claims wherein after precious metal recovery a solution conditioning stage is employed to precipitate ferric sulfate and thus control the level of this species in the process.

16. A process as claimed in claim 15 wherein in the solution conditioning stage limestone and calcium carbonate are added to the solution to form a hematite/gypsum precipitate which is then filtered and disposed of with the solids residue from the leaching stage(s).

17. A process as claimed in any one of the preceding claims wherein, when a high level of carbon is present in the sulfidic material, a surfactant is added to the solution during the sulfidic material oxidation step to prevent precious metal from adsorbing onto carbon in the material, or activated carbon is added to the solution during the sulfidic material oxidation step to preferentially adsorb precious metal onto the activated carbon.

18. A process as claimed in claim 17 wherein the surfactant is one or more organic solvents including kerosene or a phenol ether.

19. A process for removing a contaminant from a contaminated sulfidic material comprising the steps of:

- mixing the material in an aqueous solution wherein a multi-valent species of a relatively high oxidation state oxidises the contaminant to render it soluble in the solution, produces a contaminant refined material, and is reduced to a relatively lower oxidation state; and
- removing the contaminant from the solution whilst regenerating the multi-valent species to its relatively high oxidation state.

20. A process for removing a contaminant from a contaminated sulfidic material comprising the steps of:

- mixing the material in an aqueous solution having an oxidation potential controlled to oxidise substantially only the contaminant to render it soluble in the solution, thereby producing a contaminant refined material; and
- separating the solution from the contaminant refined material.

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21. A process as claimed in claim 19 or 20 wherein the contaminant is removed from the solution by precipitation in a separate precipitation stage by introducing an oxidant into the solution.
- 5 22. A process as claimed in claim 21 wherein, in the precipitation stage, the solution pH is typically maintained at around pH 1.5-3.
- 10 23. A process as claimed in any one of claims 19 to 22 wherein the contaminant is oxidised and leached into solution in a two stage leaching process, wherein in a first leaching stage the oxidation potential is controlled to oxidise substantially only the contaminant to render it soluble in the solution, and in a second leaching stage the oxidation potential is increased to oxidise sulfide in the contaminant refined material.
- 15 24. A process as claimed in claim 23 wherein the contaminant refined material is separated from the solution after the first leaching stage and is fed to the second leaching stage, and the solution is separated from the contaminant refined material after each leaching stage for removal of contaminant therefrom by precipitation.
- 20 25. A process as claimed in claim 23 or 24 wherein the sulfidic material is a pyritic material and in the first leaching stage the contaminant is oxidised in an acidic aqueous solution of pH less than 1, at a solution Eh sufficient to oxidise the contaminant into solution but not substantially leach pyrite, and at a temperature up to about 105°C, and in the second leaching stage the pyritic material is also oxidised in an acidic aqueous solution of pH less than 1, but at a higher solution Eh sufficient to leach pyrite, and at a
25 temperature up to about 105°C.
26. A process as claimed in claim 25 wherein, in the second leaching stage, an oxidant such as oxygen, air, chlorine gas, hydrogen peroxide is added to the solution.
- 30 27. A process as claimed in any one of claims 19 to 26 wherein the the solution is recycled throughout the process and is a dissolved metal chloride solution having a chloride concentration of approximately 8 moles per litre, with the metal in the dissolved metal chloride solution functioning as the multi-valent species.
- 35 28. A process as claimed in any one of claims 19 to 27 wherein the sulfidic material has a high level of carbon present therein and a surfactant is added to the solution during

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contaminant oxidation to prevent precious metals from adsorbing onto carbon in the material.

5 29. A process as claimed in any one of claims 19 to 28 further comprising one or more metal recovery stages to recover metal leached into solution with the contaminant and/or that is present in the residual contaminant refined material.

10 30. A process as claimed in claim 29 wherein the sulfidic material is a double-refractory ore that includes carbon, and a metal recovery stage is provided subsequent to a final leaching stage to recover metal present in the residual contaminant refined material that has adsorbed onto the carbon.

15 31. A process as claimed in claim 30 wherein the metal recovery stage comprises a conventional roasting or smelting process, optionally with chlorine or cyanide leaching after roasting or smelting to recover any remaining metal in the roasted solids material.

20 32. A process as claimed in any one of claims 29 to 31 wherein an in-line metal recovery stage is provided prior and/or or subsequent to contaminant precipitation to remove any metal that is leached into solution in the leaching stage.

33. A process as claimed in any one of claims 29 to 32 wherein, prior to metal recovery, a number of material separation stages are provided to separate the contaminant refined material from the solution.

25 34. A process as claimed in claim 33 wherein the separated solution after the or each leaching stage is passed to contaminant recovery, whereas the separated refined material is passed to metal recovery or disposal.

30 35. A process as claimed in any one of claims 23 to 34 wherein, after contaminant precipitation, a contaminant separation stage is provided to remove the contaminant from solution prior to recycling the solution to the leaching stage.

35 36. A process for treating a contaminated sulfidic material having a relatively high carbon content to allow recovery of precious metal in the material, comprising the steps of:

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- leaching the material in an aqueous solution wherein the metal is leached into solution, whilst carbon in the material is masked to prevent precious metal adsorption thereon; and
- recovering the precious metal from the solution.

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37. A process as claimed in claim 36 wherein the carbon is masked with a surfactant as defined in claim 18.

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38. A process as claimed in claim 36 or 37 which is otherwise as defined in any one of claims 1 to 35.

39. Any metal produced by the process of any one of the preceding claims.